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# FINANCIALIZATION AND DYNAMICS OF CURRENCY FUTURES MARKET DURING COVID-19: EVIDENCE FROM INDIA

**Keywords:** financialization, exchange rates, style investment, financial crisis, COVID-19, structural breaks.

**J E L Classification:** C1, C5, G13, G14, G17.

**Abstract:** This study examines inter-relationship and impact of COVID-19 on Indian currency and equity futures markets during the period of financial crisis. In such period, investors look for alternative asset classes to hedge against risk as observed during Global Financial Crisis. This study examines whether same phenomenon was observed after COVID-19 in India considering currency futures as an alternate asset class. For this purpose daily exchange rate of Indian Rupee with British Pound Sterling, Japanese Yen, Euro and United States Dollar and for equity futures, near-month NIFTY 50 futures

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contracts are used. After examining stationarity of data, Co-integration test, Granger causality and Bi-variate correlation is applied. ARCH and DCC-GARCH model is employed to allow for heteroscedasticity and time variation in correlation. It is observed that YEN, JPY and USD display significantly negative correlation with Nifty futures. Currency futures is causing Nifty futures during COVID-19 period and leads Nifty futures by one day. However, it is other way around during pre-COVID-19 period. Long-run co-integration is not evident. ARCH effect is present in both time series and except for insignificant short-run shock persistence during COVID-19 period, there exists time varying correlation between currency returns and Nifty.

## ■■■ INTRODUCTION

The present study examines connectedness and inter-relationship between currency and equity futures markets in India. In recent period, increased interest in portfolio diversification across asset classes has stimulated investors to look for assets that have potential to provide protection against shocks due to market stress (Zghal & Ghorbel, 2022). Therefore, cross-asset integration has become significant concern due to increased association between currency and equity futures markets (Aravind, 2017; Mittal, Sehgal & Mittal, 2019).

According to portfolio rebalancing approach, an increase in the stock price attracts domestic investor to withdraw funds from foreign exchange and invest it in stock market, which leads to depreciation of exchange rate. However, when stock prices decline, stock market exhibits selling pressure as investors may try to avoid further losses, which in turn, leads to withdrawal of funds from stock market and investment in foreign currency. As a result, exchange rate may rise (Aravind, 2017). Therefore, negative shock in one market can prove to be a positive shock in other market as any change in price of asset in one market can lead investors to change their position in other market so that hedging ratio remains same (Maitra & Dawar, 2019).

This spillover of shock from one market to other is explained by the theory of style investing, which is a process of classification of large number of assets classes like equity, debt, commodities, currency etc. into different categories (styles) based on some common characteristics and allocating funds among these styles, rather than individual securities (Barberis & Shleifer, 2003). Styles force prices to deviate from their fundamental values as they generate common factors in the assets within styles, which may be completely different otherwise and asset starts co-moving with other assets within style (Adams & Gluck, 2015).

This phenomenon can be understood with figure 1. In broad area of investment management, investors can focus on one particular asset or may go for portfolio diversification. If they choose to diversify through portfolio, they can include a mix of asset classes such as equity, commodity, currency etc. in their portfolio, which becomes their investment style. Now, if any kind of association in the form of correlation or spillover occurs within a style, it leads to financialization of asset class.

**Figure 1.** Understanding Style Investing
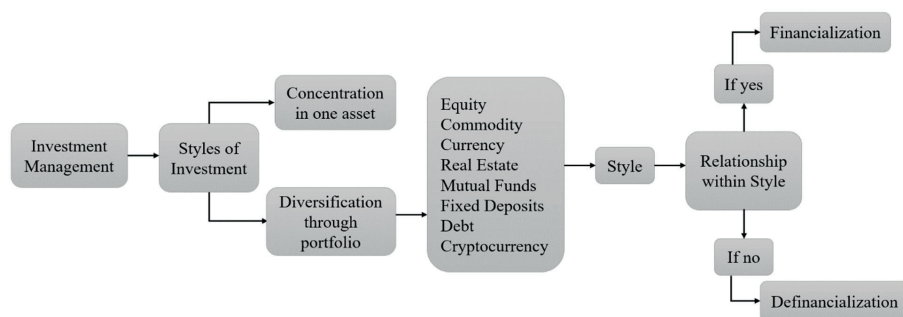


S o u r c e : compiled by authors from various arguments in the review of literature.

Currency is often included as an asset class in the professionally managed portfolios like hedge funds and mutual funds, in which they invest for the purpose of portfolio rebalancing, which led to its integration with other financial markets (Kutty, 2010). This process of integration is known as financialization where dominance of finance industry increases and its role expands in overall economy (Casey, 2011).

This kind of market behavior is more evident after the period of financial crisis (Solnik, 1987; Shen, Tang, Xing & Ng, 2020). The spillover from one market to other were non-existent before Global Financial Crisis (GFC), however, it was observed afterwards (Kumar & Gupta, 2023). Büyüksahin and Robe (2014) also observed that after GFC period, cross linkages between commodity market and equity market increased. Similar evidences are available in different studies conducted in different financial markets (Kang, Maitra, Dash & Brooks, 2019; Chatziantoniou, Filippidis, Filis & Gabauer, 2021). In addition, Asian financial crisis 1997 also made significant impact on Asia-Pacific real estate mar-

kets. Before crisis period, these markets were not integrated, however, it became integrated afterwards (Gerlach, Wilson & Zurbruegg, 2006). Therefore, financial crisis can increase connectedness in different markets due to chain of reactions from investors during and after crisis period (Kang & Lee, 2019).

Similarly, the negative impact of COVID-19 on financial markets around the world is evident (Mirza, Naqvi, Rahat & Rizvi, 2020). The policies adopted to control the spread of disease contributed to supply shock. To safeguard staff from catching infection, offices and factories were shut down entirely (Liu, Manzoor, Wang, Zhang, & Manzoor, 2020). It hampered the economic activity around the world badly. Therefore, equity markets fell badly (Joshi, 2022) and this health crisis translated into financial and economic crisis also (Sahoo, 2021). Negative sentiment of investors proved to be the best explanation for significant fall of equity markets around the world (Liu et al., 2020).

In the backdrop of the theory of financial crisis and its effect on different markets and market behavior of investors, this study examines inter-relationship and connectedness across two asset classes namely Nifty futures and Currency futures in India. Following are noticeable research gaps. Firstly, to the best of author's knowledge, there is no study that examines inter-relationship between these two markets during COVID-19. Secondly, there is limited and yet unsettled debate in literature[1] on relationship between these two markets in India.

In literature[2], there is divergent evidence on influence of currency market on equity market. Adjasi, Harvey and Agyapong (2008) observed inverse relationship between exchange rate volatility and equity market returns in Ghana stock exchange. However, Kutty (2010) found no relationship between the two markets during long-run in Mexico stock exchange. Furthermore, very weak relationship was observed between equity market and exchange rate in Johannesburg Stock Exchange (Mlambo, Maredza & Sibanda, 2013).

In the Indian context, Agrawal, Srivastav and Srivastava, (2010) observed inverse relationship between pair of INR/USD currency and Nifty returns. However, Yadav (2016) found this correlation insignificant and observed uni-directional causality was also observed from equity market to currency mar-

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[1] Please see Frankel and Rodriguez (1975), Yadav (2016), Aravind (2017) and Maitra and Dawar (2019).

[2] Please see Adjasi et al., (2008), Agrawal et al., (2010), Kutty (2010) and Mlambo et al., (2013).

ket. However, Aravind (2017) found no causality between these two markets. In addition, Maitra and Dawar (2019) observed that only USD affects Nifty and Sensex while both indices affect exchange rate.

Derivatives were first launched in India in equity segment at National Stock Exchange (NSE) with introduction of Index futures contracts in June, 2000. In addition, trading in currency futures was launched at NSE in August, 2008[3]. Since then, there is tremendous growth in volume of trading of both instruments. Index futures and equity futures are consistently in top 10 countries among Global derivative exchanges since 2011 with exception of 2018 while currency futures are in top 3 countries since 2014 in terms of number of contracts traded[4].

Furthermore, it is noticeable that Indian equity market is substantially participated by Foreign Portfolio Investors (FPI). In financial year 2020-21, equity market recorded a net investment of ₹ 274 thousand crore from FPIs (Annual Report of Securities and Exchange Board of India, 2020-21. However, COVID-19 negatively affected Indian equity market. Two benchmark indices i.e. Nifty and Sensex fall by 23.8% and 26% respectively during financial year 2019-20 (Annual Report of Securities and Exchange Board of India, 2019-20). Furthermore, during initial phase of COVID-19, net foreign portfolio investment in equity segment became negative and it remained volatile afterwards (figure 2).

Therefore, it is evident from the above figure that foreign portfolio investment fall significantly and remained volatile during COVID-19 period in India. However, there is dearth of studies in such an important market and the evidence is contradicting (Agrawal et al., (2010), Yadav (2016) and Aravind (2017)). Furthermore, to the best of author's knowledge, no study is available in literature that studies COVID-19 as structural break. Therefore, present study attempts to plug this research gap and contribute to the scarce literature.

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[3] Please see Indian Securities Market, A Review 2008-09 report, page no. 158 and 174, available at https://www1.nseindia.com/research/dynaContent/ismr.htm.

[4] Please see IOMA Derivative Market Survey Report, 2020, page no. 17 and 30, available at https://www.world-exchanges.org/our-work/articles/derivatives-report-2020.

**Figure 2.** Foreign Portfolio Investment monthly data for the year 2020



**Net Foreign Portfolio Investment (Equity) in 2020**

Initial phase of COVID-19 in India
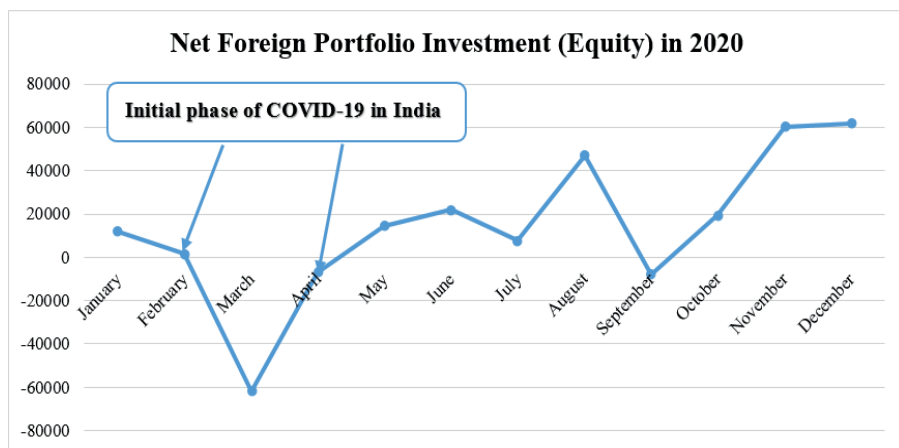
S o u r c e : based on Foreign Portfolio Investment monthly data extracted from website of National Securities Depository Limited (NSDL) for year 2020.

The remaining paper is structured as follows: *section 2* presents detail of data, *section 3* depicts methodology used to conduct this study and is followed by *section 4*, which focuses on results and discussions of study. *Section 5* concludes the study.

## THE RESEARCH METHODOLOGY AND THE COURSE OF THE RESEARCH PROCESS

### Data Descriptions

Indian Rupee is paired with 4 major currencies namely YEN, EUR, GBP and USD[5]. The daily exchange rate data for YEN (¥), EUR (€), GBP (£) and USD ($) to Indian Rupee (₹) and for Nifty Futures near month contracts has been downloaded from the official website of NSE. Data is downloaded for the period as mentioned in table 1.

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[5] Please see Annual Report of Securities and Exchange Board of India, 2020-21, page no. 102 available at https://www.sebi.gov.in/sebiweb/home/HomeAction.do?doListing=yes&sid=4&ssid=80&smid=101.

**Table 1.** Description of Sample Period

| For Equity | For Currency | Full Sample Period | Impact of COVID-19 | |
|---|---|---|---|---|
| | | | **Pre-COVID-19** | **During COVID-19** |
| **Nifty 50 Index Futures** | YEN (For 100 ¥ to 1 ₹) | Feb 2010 to Nov 2021 | Feb 2010 to Dec 2019 | Jan 2020 to Nov 2021 |
| | EUR (For 1 € to 1 ₹) | Feb 2010 to Nov 2021 | Feb 2010 to Dec 2019 | Jan 2020 to Nov 2021 |
| | GBP (For 1 £ to 1 ₹) | Feb 2010 to Nov 2021 | Feb 2010 to Dec 2019 | Jan 2020 to Nov 2021 |
| | USD (For 1 $ to 1 ₹) | Sept 2008 to Nov 2021 | Sept 2008 to Dec 2019 | Jan 2020 to Nov 2021 |

S o u r c e : compiled by author.

Data for currency pairs has been taken from the date of inception of trading in respective currencies to November, 2021. Analysis is done for full period as well as after dividing the data into structural breaks for pre and during COVID-19 periods.

## Materials and Methods

To examine the presence of unit root in currency and Nifty futures contracts, Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests are used. First difference log returns of both time series are found to be stationery. The results are reported not reported to save space, however same are available on demand. Moreover, to check for the co-movement between these two markets, Johansen's Co-integration test is used. Furthermore, to check for direction of spillover between these markets, Granger Causality test is applied. In addition, Bi-variate correlation is also examined to check degree of association between these markets. Vector Auto Regression (VAR) is also applied to check lead-day relationship between two markets. In addition, Auto Regressive Conditional Heteroscedasticity (ARCH) test is applied to check for the Heteroscedasticity in return series of both currencies and NIFTY. DCC GARCH model has been used also to account for the time varying correlation between the two series. This model has been employed because if the time series under study is heteroskedastic in nature and it needs to be tested through a model, which allows variation due to conditional factors (Singhal & Ghosh, 2016). Moreover, when more and more variables are added to this system, the correlation results do not differ and the model remains accurate (Engle, 2002).

The Covariance matrix in DCC-GARCH model proposed by Engle (2002) is explained as follows:

$$H_t = D_t R_t D_t$$

Where:
$H_t$ = Conditional Covariance Matrix,
$D_t$ = kxk Diagonal matrix of time varying standard deviation from univariate GARCH model with $(\sigma^2_{i,t})^{1/2}$ on ith diagonal,
$R_t$ = Time varying correlation matrix.

To fit this model, $R_t$ has to be positive and the sum of estimated parameters should be less than or equal to 1. On the basis of given methodology, two parameters i.e $\theta_1$ and $\theta_2$ are estimated. Theta 1 parameter is associated with short-run persistence and theta 2 with long-run persistence of shock on dynamic conditional correlation.

## The Outcome Of The Research Process And Conclusions

### Descriptive Statistics

The results of descriptive statistics are reported in Table 2(a) and 2(b). Mean returns for all currencies and Nifty are approximately zero, which indicates that market exhibits mean reversion behavior. Moreover, returns for all subperiods for currencies (except Yen during COVID-19 period) are positive, which shows depreciation of INR against various currencies during the sample period. Nifty returns for all sub – periods are positive, which confirms continuous growth of Indian equity market[6].

In addition, co-efficient of skewness and kurtosis are significant for both asset classes during all sub-periods, which confirms that returns are not normally distributed and are leptokurtic, which is confirmed by Jarque-Bera statistics that all return series are significant at 5% level of significance.

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[6] Please see Indian Securities Market, A Review 2019 report, page no. 18, available at https://www1.nseindia.com/research/dynaContent/ismr.htm.

**Table 2(a).** Descriptive Statistics (Currency Futures Contracts)

| | Full Sample Period | | | | Pre-COVID – 19 | | | | During COVID – 19 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yen | Euro | GBP | USD | Yen | Euro | GBP | USD | Yen | Euro | GBP | USD |
| Observations | 2934 | 2934 | 2934 | 3277 | 2459 | 2459 | 2459 | 2802 | 475 | 475 | 475 | 475 |
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.00 | 0.00 | 0.00 | 0.00 |
| Median | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.00 | 0.00 | 0.00 | 0.00 |
| Std. Dev. | 0.01 | 0.01 | 0.01 | 0.01 | 0.04 | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| Skewness | 0.29 | 0.02 | -0.49 | 0.28 | 0.29 | 0.15 | -0.57 | 0.23 | 0.17 | 0.73 | -1.71 | 0.9 |
| Kurtosis | 7.06 | 6.48 | 12.40 | 7.76 | 6.57 | 6.33 | 13.38 | 7.49 | 11.40 | 5.64 | 20.58 | 8.67 |
| Jarque-Bera Test | 2055.2* | 1499.3* | 10926.3* | 3146.3* | 1342.8* | 1143* | 11180.9* | 2386.8* | 1400.2* | 81.2* | 6346.6* | 701.1* |

*Significant at 1% level of significance

S o u r c e : based on author's calculations.

**Table 2(b).** Descriptive Statistics (Nifty Futures Contracts)

| Against | Full Sample Period | | Pre-COVID – 19 | | During COVID – 19 |
|---|---|---|---|---|---|
| | Yen, Euro and GBP | USD | Yen, Euro and GBP | USD | Yen, Euro, GBP and USD |
| Observations | 2934 | 3277 | 2459 | 2802 | 475 |
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Median | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Std. Dev. | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Skewness | -0.89 | -0.30 | -0.09 | 0.15 | -1.71 |
| Kurtosis | 17.44 | 20.12 | 5.01 | 19.11 | 20.58 |
| Jarque-Bera Test | 25876.3* | 40105.2* | 417.1* | 30299.6* | 6346.6* |

*Significant at 1% level of significance

S o u r c e : based on author's calculations.

## Bi-variate Correlation

The results (Table 3) show that except for GBP, all currencies exhibit negative correlation during all sub-periods and it is statistically significant at 5% level of significance (Agrawal et al., 2010). This may be due to the argument explained earlier that positive news in one market can be negative in other market (Maitra and Dawar, 2019). These results are consistent with Aravind (2017), which states that when currency and equity are viewed as asset classes, there should be inverse relationship between two markets for the reason that investor employs funds in asset class that flourishes by withdrawing it from underperforming asset.

**Table 3.** Bi-variate Correlation

| Event | YEN and Nifty 50 Futures | EUR and Nifty 50 Futures | GBP and Nifty 50 Futures | USD and Nifty 50 Futures |
|---|---|---|---|---|
| | Coefficient | Coefficient | Coefficient | Coefficient |
| Full Sample Period | -0.38* | -0.18* | 0.11* | -0.45* |
| Pre-COVID-19 | -0.41* | -0.19* | -0.17* | -0.45* |
| During COVID-19 | -0.36* | -0.17* | 0.09* | -0.44* |

*Significant at 1% level of significance

S o u r c e : based on author's calculations.

## Granger Causality Test

The results (Table 4) display that for all currencies except for GBP, currency futures is causing Nifty futures during COVID-19 period i.e. the period of market stress. However, weak causality is also observed from Nifty futures to currency during this period for EUR, GBP and USD. Currency futures may be leading Nifty futures due to the fact that during COVID-19 period, net foreign portfolio investment in equity segment became negative (Figure 2), which led to fall in equity market.

In addition, Nifty futures is causing currency futures for all four currencies in pre-COVID-19 period and strong uni-directional causality is observed from Nifty to currency futures in case of USD during the full sample period (Yadav, 2016). This result is also consistent with argument given by Aravind (2017)

that, when equity market flourishes, it attracts foreign investment. Furthermore, no causality is observed during full sample period in case of Yen and GBP (Aravind, 2017), which may be due to the fact that biggest percentage of asset holding at NSE in equity segment is of United States of America, who holds 34.3 percentage of total equity assets of FPIs as on March 31, 2021, however, United Kingdom and Japan holds 5.3 percent and 2.6 percent shares respectively[7]. Therefore, there may be no causality in case of YEN and GBP either to or from equity futures market.

**Table 4.** Granger Causality Test

| Event | Null Hypothesis | YEN F Statistics | EUR F Statistics | GBP F Statistics | USD F Statistics |
|---|---|---|---|---|---|
| **Full Sample Period** | NFR does not cause CFR | 1.01 | 1.63 | 1.30 | 4.48* |
| | CFR does not cause NFR | 1.38 | 1.80*** | 0.82 | 1.09 |
| **Pre-COVID-19** | NFR does not cause CFR | 5.25** | 6.84* | 3.03** | 4.67* |
| | CFR does not cause NFR | 1.52 | 0.59 | 0.82 | 1.50 |
| **During COVID-19** | NFR does not cause CFR | 1.28 | 1.73*** | 4.27* | 2.35** |
| | CFR does not cause NFR | 4.37* | 3.55* | 0.83 | 2.84* |

*Significant at 1% level of significance
**Significant at 5% level of significance
***Significant at 10% level of significance

**Note:**

• NFR denotes Nifty Futures Returns
• CFR denotes Currency Futures Returns

S o u r c e : based on author's calculations.

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[7] Please see Annual Report of Securities and Exchange Board of India, 2020-21, page no. 163 available at https://www.sebi.gov.in/sebiweb/home/HomeAction.do?doListing=yes&sid=4&ssid=80&smid=101.

## Johansen Co-integration Test

The results are reported in table 5 (a-d). There is an evidence of long-run relationship between equity futures and currency futures in case of YEN during COVID-19 period only (Kutty, 2010). Nevertheless, the evidence is weak. Therefore, Vector Error Correction Methodology (VECM) is not applied. For other currencies namely GBP, EUR and USD, there is no evidence of long-run relationship between equity futures and currency futures market in any sub-period as well as full period.

**Table 5.** Johansen's Co-integration Test

(a) Yen and Nifty Futures

| Event | Hypothesized No. of CE(s) | Eigen Value | Maximum Eigen Value Test | Trace Test Critical Values |
|---|---|---|---|---|
| | | | Test Statistics | Test Statistics |
| Full Sample Period | None | 0.00 | 8.01 | 11.95 |
| | At Most 1 | 0.00 | 3.93 | 3.93 |
| Pre-COVID-19 | None | 0.00 | 8.21 | 13.76 |
| | At Most 1 | 0.00 | 5.55 | 5.55 |
| During COVID-19 | None | 0.04 | 17.92*** | 27.46** |
| | At Most 1 | 0.02 | 9.54 | 9.54 |

*Significant at 1% level of significance
**Significant at 5% level of significance
***Significant at 10% level of significance

S o u r c e : based on author's calculations.

## (b) EUR and Nifty Futures

| Event | Hypothesized No. of CE(s) | Eigen Value | Maximum Eigen Value Test | Trace Test Critical Values |
| --- | --- | --- | --- | --- |
| | | | Test Statistics | Test Statistics |
| Full Sample Period | None | 0.00 | 9.01 | 15.25 |
| | At Most 1 | 0.00 | 6.24 | 6.24 |
| Pre-COVID-19 | None | 0.00 | 10.12 | 14.90 |
| | At Most 1 | 0.00 | 4.78 | 4.78 |
| During COVID-19 | None | 0.03 | 15.22 | 21.75 |
| | At Most 1 | 0.01 | 6.53 | 6.53 |

S o u r c e : based on author's calculations.

## (c) GBP and Nifty Futures

| Event | Hypothesized No. of CE(s) | Eigen Value | Maximum Eigen Value Test | Trace Test Critical Values |
| --- | --- | --- | --- | --- |
| | | | Test Statistics | Test Statistics |
| Full Sample Period | None | 0.00 | 5.43 | 9.61 |
| | At Most 1 | 0.00 | 4.19 | 4.19 |
| Pre-COVID-19 | None | 0.00 | 9.56 | 12.81 |
| | At Most 1 | 0.00 | 3.24 | 3.24 |
| During COVID-19 | None | 0.03 | 12.75 | 21.95 |
| | At Most 1 | 0.02 | 9.20 | 9.20 |

S o u r c e : based on author's calculations.

(d) USD and Nifty Futures

| Event | Hypothesized No. of CE(s) | Eigen Value | Maximum Eigen Value Test | Trace Test Critical Values |
|---|---|---|---|---|
| | | | Test Statistics | Test Statistics |
| Full Sample Period | None | 0.00 | 8.64 | 14.31 |
| | At Most 1 | 0.00 | 5.66 | 5.66 |
| Pre-COVID-19 | None | 0.00 | 10.52 | 17.21 |
| | At Most 1 | 0.00 | 6.68 | 6.68 |
| During COVID-19 | None | 0.03 | 13.17 | 22.17 |
| | At Most 1 | 0.02 | 8.99 | 8.99 |

S o u r c e : based on author's calculations.

## Vector Auto Regression (VAR)

The results in Table 6 (a-d) exhibits that during COVID-19 period, currency futures lead Nifty futures by one day. It may be due to the reason that during COVID-19 period, there was so much volatility in foreign portfolio investment (Figure 2), which created a spillover effect on equity futures market and it started following currency futures market and also there is difference in timing of market operation.

However, in pre-COVID-19 period, Nifty futures was leading currency futures by one day. This is consistent with the argument given above that during bull-run of equity market, more foreign investment is attracted. In full sample period, lead-lag relationship is observed only in case of YEN and EURO. In case of YEN, currency futures lead Nifty futures by one day and in case of EURO, it is other way around.

**Table 6.** Vector Auto Regression Methodology

(a) Yen

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| Constant | 0.77 | 2.02** | 0.78 | 1.76*** | -0.12 | 0.76 |
| CFR(-1) | -0.43 | 2.05** | -0.57 | 1.23 | -1.51 | 3.65* |
| CFR(-2) | -1.27 | -0.52 | NA | NA | 2.17** | -2.80* |
| CFR(-3) | -1.39 | 0.48 | NA | NA | -0.03 | 0.80 |
| CFR(-4) | 1.95*** | -0.48 | NA | NA | 0.96 | -1.15 |
| CFR(-5) | 0.16 | 0.39 | NA | NA | 1.01 | -1.23 |
| CFR(-6) | 0.25 | -1.31 | NA | NA | -0.36 | -1.21 |
| CFR(-7) | -0.88 | -1.07 | NA | NA | -0.66 | -1.63 |
| NFR(-1) | -0.96 | 0.22 | -2.29** | 1.98** | 0.89 | 0.36 |
| NFR(-2) | -1.35 | 0.63 | NA | NA | 1.59 | -1.53 |
| NFR(-3) | -0.49 | 0.74 | NA | NA | 1.53 | 2.12** |
| NFR(-4) | 0.08 | -0.93 | NA | NA | 0.16 | -2.27** |
| NFR(-5) | -1.21 | 3.37* | NA | NA | -1.33 | 4.20* |
| NFR(-6) | 0.87 | -3.83* | NA | NA | 0.64 | -3.55* |
| NFR(-7) | -1.34 | 1.95*** | NA | NA | -1.01 | 2.83* |

*Significant at 1% level of significance
**Significant at 5% level of significance
***Significant at 10% level of significance

S o u r c e : based on author's calculations.

(b) EUR

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| Constant | 1.04 | 2.04** | 0.94 | 1.85*** | 0.43 | 0.84 |
| CFR(-1) | 3.96* | -0.06 | 3.19* | -1.07 | 2.03** | 2.37** |

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**Table 6.** Vector...

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| CFR(-2) | -1.50 | 1.02 | -1.81 | 0.24 | -0.43 | 1.75*** |
| CFR(-3) | -0.76 | -1.16 | NA | NA | 1.76*** | -0.70 |
| CFR(-4) | 0.87 | 2.06** | NA | NA | 1.48 | 0.39 |
| CFR(-5) | 2.42** | -1.62 | NA | NA | 1.51 | -2.49** |
| CFR(-6) | -1.01 | 0.25 | NA | NA | -0.85 | -1.95*** |
| CFR(-7) | -0.26 | -2.12** | NA | NA | -0.61 | -2.18** |
| NFR(-1) | -2.22** | -0.51 | -3.36* | 1.38 | 1.39 | -1.52 |
| NFR(-2) | -0.49 | 0.92 | -1.48 | 0.12 | 1.53 | -0.13 |
| NFR(-3) | 0.22 | 0.49 | NA | NA | 1.03 | 1.51 |
| NFR(-4) | -1.81*** | -0.48 | NA | NA | -1.56 | 0.62 |
| NFR(-5) | -1.02 | 3.20* | NA | NA | -1.81*** | 4.46* |
| NFR(-6) | 1.23 | -3.59* | NA | NA | 1.01 | -2.99* |
| NFR(-7) | -0.95 | 2.34** | NA | NA | -0.40 | 2.86* |

S o u r c e : based on author's calculations.

(c) GBP

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| Constant | 0.94 | 2.04** | 0.93 | 1.83*** | 0.21 | 0.74 |
| CFR(-1) | 3.68* | -0.08 | 3.44* | -0.84 | -0.11 | 1.77*** |
| CFR(-2) | -1.21 | 1.69*** | -2.35** | 1.01 | 0.58 | 0.84 |
| CFR(-3) | -0.44 | -0.91 | NA | NA | 0.68 | -0.21 |
| CFR(-4) | 0.64 | 0.06 | NA | NA | 1.02 | 0.04 |
| CFR(-5) | 0.92 | -0.95 | NA | NA | -1.36 | -0.34 |
| CFR(-6) | 0.91 | -0.75 | NA | NA | 0.33 | -0.88 |
| CFR(-7) | -1.01 | -0.82 | NA | NA | -3.91* | -0.92 |

**Table 6.** Vector…

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| NFR(-1) | -1.44 | -0.62 | -2.34** | 1.35 | 1.33 | -1.56 |
| NFR(-2) | 1.66*** | 1.03 | -0.71 | 0.29 | 4.39* | -0.16 |
| NFR(-3) | 0.73 | 0.55 | NA | NA | 3.06* | 1.47 |
| NFR(-4) | -1.79*** | -0.84 | NA | NA | -0.83 | 0.16 |
| NFR(-5) | -0.78 | 3.31* | NA | NA | 0.11 | 4.40* |
| NFR(-6) | 0.27 | -3.68* | NA | NA | -0.41 | -3.07* |
| NFR(-7) | 0.17 | 2.67* | NA | NA | 0.65 | 3.12* |

S o u r c e : based on author's calculations.

(d) USD

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| Constant | 2.06** | 1.85*** | 1.92*** | 1.81*** | 0.89 | 0.59 |
| CFR(-1) | 0.07 | 0.25 | 0.41 | -0.57 | -2.22** | 2.27** |
| CFR(-2) | -3.79* | -1.85*** | -3.50* | -2.33** | -1.57 | 0.69 |
| CFR(-3) | 0.14 | -0.66 | -0.05 | -1.47 | 0.13 | 1.49 |
| CFR(-4) | 0.16 | 0.56 | 0.23 | -0.26 | -0.71 | 1.59 |
| CFR(-5) | 2.81* | -0.33 | 2.84* | -1.06 | 0.61 | 0.35 |
| CFR(-6) | -0.58 | -1.69*** | -0.89 | -0.63 | 0.67 | -3.11* |
| CFR(-7) | 2.11** | -0.29 | 2.16** | -0.76 | 0.56 | -0.68 |
| CFR(-8) | 0.00 | 0.81 | -0.13 | 1.49 | NA | NA |
| NFR(-1) | -3.75* | 0.97 | -3.97* | 1.89*** | -1.09 | -0.53 |
| NFR(-2) | -1.89*** | -1.71*** | -1.39 | -2.83* | -1.28 | 0.53 |
| NFR(-3) | -2.49** | 0.40 | -2.46** | -0.72 | -0.38 | 2.48** |
| NFR(-4) | -2.59* | -0.81 | -2.86* | -1.12 | -0.48 | 1.21 |
| NFR(-5) | 0.23 | 1.45 | 1.43 | -1.53 | -2.61* | 4.54* |

**Table 6.** Vector...

| Event | Full Sample Period | | Pre-COVID 19 | | During COVID-19 | |
|---|---|---|---|---|---|---|
| | CFR | NFR | CFR | NFR | CFR | NFR |
| NFR(-6) | 2.21** | -4.86* | 1.06 | -2.42** | 2.11** | -4.24* |
| NFR(-7) | 0.01 | 0.02 | -0.21 | 0.63 | -0.78 | 2.17** |
| NFR(-8) | 1.33 | 2.32** | 1.51 | 2.71* | NA | NA |

S o u r c e : based on author's calculations.

## ARCH and DCC GARCH Parameters

From table 7, it is observed that heteroscedasticity is present in all return series of currencies as well as NIFTY. All the p-values are significant at 1% level of significance. Therefore, checking correlation through static models can be misleading and give false results. Hence, DCC-GARCH model is applied, which is a heteroscedastic model and also allows for variation in correlation due to time.

**Table 7.** ARCH Parameters

| Event | ARCH (NIFTY) | ARCH (YEN) | ARCH (EURO) | ARCH (GBP) | ARCH (USD) |
|---|---|---|---|---|---|
| Full Period | 64.42* | 37.71* | 29.91* | 24.79* | 62.34* |
| Pre-COVID-19 Period | 51.32* | 16.91* | 20.07* | 13.72* | 52.27* |
| During COVID-19 Period | 3.42* | 36.51* | 16.73* | 23.22* | 4.74* |

*Significant at 1% level of significance

S o u r c e : based on author's calculations.

From table 8, it is clear that there exists time varying correlation between currency returns for all 4 currencies and Nifty. Both parameters i.e theta 1 and theta 2 are significant in full period, which states that there is both short-run and long-run persistence of shock on dynamic conditional correlation. All the results for full period and pre-COVID 19 period are significant at 1% level of significance. However, during COVID-19 period, short run persistence of shock became insignificant at 5% level of significance, which clearly indicates that

COVID-19 changed some dynamics of market for both currency and equity for short term. This may be due to the reason that there was a huge outflow of Foreign Portfolio Investment (FPI) from Indian equity markets. However, long-run persistence indicated by theta 2 became significant again for all currencies except GBP, which indicates that once the initial period of COVID-19 passed, FPI inflow again became significant. Therefore, with these changed dynamics of market, time varying correlation again became significant. In addition, for all sub-periods, stability condition of model i.e all parameters should be definite positive and their sum should be less than or equal to 1 is also met. Therefore, there is a definite time varying correlation between both markets in both short-run and long-run.

**Table 8.** DCC-GARCH Parameters

| Event | DCC Parameters | GARCH (YEN) | GARCH (EURO) | GARCH (GBP) | GARCH (USD) |
|---|---|---|---|---|---|
| Full Period | $\theta_1$ | 0.02* | 0.01* | 0.01* | 0.01* |
| | $\theta_2$ | 0.93* | 0.97* | 0.98* | 0.96* |
| Pre COVID -19 Period | $\theta_1$ | 0.03* | 0.01* | 0.00** | 0.01* |
| | $\theta_2$ | 0.92* | 0.97* | 0.98* | 0.97* |
| During COVID -19 Period | $\theta_1$ | 0.01 | 0.01*** | 0.11*** | 0.02 |
| | $\theta_2$ | 0.97* | 0.97* | 0.85 | 0.83* |
| Stability Condition | Theta (1) + Theta (2) < 1 is met. | | | | |

*Significant at 1% level of significance

S o u r c e : based on author's calculations.

◼◼◼ Conclusion

Present study examines inter-linkages between currency and Nifty futures markets in India. Daily closing prices of currency futures of four major currencies namely YEN, EUR, GBP and USD to Indian Rupee and Nifty futures contracts has been downloaded from the website of NSE from the date of inception of trading of respective currency futures contracts to November, 2021. COVID-19 is taken as structural break intuitively and data is divided into three sub-periods i.e. Full sample period, pre-COVID-19 and during COVID-19.

It is stated that except GBP, all currencies display significantly negative correlation with Nifty futures contracts (Aravind, 2017), which may be an evidence of financialization. In addition, currency futures is causing Nifty futures during COVID-19 i.e. period of market turmoil, which may be due to volatility in net foreign portfolio investment during this period. However, in pre-COVID-19 period, Nifty was causing currency futures (Yadav, 2016). Furthermore, there is no long-run relationship between these two markets (Kutty, 2010). Weak evidence of co-integration is found in case of Yen. Moreover, currency futures is leading Nifty futures during COVID-19 period by one day. However, in pre-COVID-19 period, Nifty futures was leading by one day. Due to presence of ARCH effect, DCC GARCH model is applied, which indicates that time varying correlation is present and both shock short-run and long-run shocks persist between two markets except for the short-run period of COVID-19.

In a nutshell, study suggests that there is an evidence of financialization of currency futures market in India, which is not documented yet in literature to the best of author's knowledge. This study also contributes to the ongoing discussion in literature by adding that integration between asset classes increases during period of market turmoil. These results are consistent with Kutty (2010), Yadav (2016) and Aravind (2017) in different aspects.

The findings may be useful for policymakers as they need to pay attention to the consequences of financialization. The investors may diversify their portfolio and make proportionate investment in different assets based on volatility and integration between markets. Furthermore, this study examines financialization of currency market only, whereas, the scope of study can be extended to other assets also i.e. bitcoin, commodities etc. This study also limits the spillover analysis to India only, whereas one can study cross-country spillover also.

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